Air Quality Monitoring in the Medicine Hat Area
Final Report - May 1998 to January 1999

Alberta Environment conducted an air quality monitoring survey in Medicine on May 26 and 27, August 26 and 27, November 4 and 5 of 1998 and January 27 and 28 of 1999. The objectives of the survey were to: (1) determine concentrations of air pollutants representative of five locations in Medicine Hat; and (2) compare air pollutant levels to Alberta's air quality guidelines and to air pollutant levels at other locations in Alberta. This monitoring survey is part of an unannounced, routine air quality monitoring program that is conducted throughout the province by Alberta Environment.

The Alberta Environment Mobile Air Monitoring Laboratory (MAML) was used to monitor air quality in Medicine Hat at five locations (fair grounds, airport, downtown, Lions Park, and Brier Industrial Park). Pollutants measured by the MAML included carbon monoxide, oxides of nitrogen, ozone, particulates, hydrocarbons, sulphur dioxide, hydrogen sulphide, total reduced sulphur and ammonia. This report presents 1998/99 Medicine Hat survey results compared to: (1) Alberta's Ambient Air Quality Guidelines; (2) air pollutant levels at other locations in Alberta for the same time period; and (3) air pollutant levels measured in downtown Medicine Hat during a 1990 survey.

Major Findings

(1) Concentrations of air pollutants measured in the Medicine Hat survey were below Alberta's Ambient Air Quality Guidelines. Alberta has one-hour air quality guidelines for carbon monoxide, nitrogen dioxide, ozone, sulphur dioxide, hydrogen sulphide and ammonia. Maximum one-hour concentrations were:

- 22% of the one-hour guideline for carbon monoxide;
- 38% of the one-hour guideline for nitrogen dioxide;
- 76% of the one-hour guideline for ozone;
- 17% of the one-hour guideline for sulphur dioxide;
- 40% of the one-hour guideline for hydrogen sulphide; and
- 1% of the one-hour guideline for ammonia.

(2) Concentrations of air pollutants typically emitted by automobiles were highest in downtown Medicine Hat. Levels of carbon monoxide, nitrogen dioxide and polycyclic aromatic hydrocarbons (PAHs) were twice as high in downtown Medicine Hat as concentrations at the other four monitoring sites. This reflects the higher concentration of vehicles in the downtown core. Locomotive emissions may also contribute to higher concentrations of these chemicals in downtown Medicine Hat.

(3) Levels of most air pollutants measured in Medicine Hat were close to those recorded at other Alberta cities with similar populations. For example, the average carbon monoxide concentration at all five sites in Medicine Hat was 0.5 ppm (parts per million) compared to 0.3 ppm in Fort McMurray and 0.6 ppm in Fort Saskatchewan for the same time period. Nitrogen dioxide concentrations in Medicine Hat were 0.011 ppm compared to 0.007 and 0.014 ppm in Fort McMurray and Fort Saskatchewan, respectively.

(4) Air quality levels measured in downtown Medicine Hat during this survey were similar to those measured at a downtown location from January to April in 1990. Average concentrations of carbon monoxide, total hydrocarbons and sulphur dioxide were identical in both air quality surveys. However, the average nitrogen dioxide concentration in downtown Medicine Hat was slightly higher in the 1998/99 survey (0.021 ppm) than in the 1990 survey (0.016 ppm). Slightly higher nitrogen dioxide values may be related an increase in downtown traffic.

(5) Slightly elevated sulphur dioxide concentrations were recorded in the Brier Industrial Park site in the early afternoon on January 28. The one-hour average concentration measured at this time was 0.029 ppm. This elevated value was likely due to emissions from an industrial facility immediately upwind of the MAML. Sulphur dioxide levels recorded during this time were below Alberta's one-hour guideline of 0.170 ppm.

(6) Elevated particulate levels were measured near noon on November 5 and 6 at the Brier Industrial Park site. The highest one-hour average inhalable particulate concentration measured at this location was 135 $\mu g/m^3$ (micrograms per cubic meter), compared to an average value of 15 $\mu g/m^3$ measured for the entire monitoring period. Elevated particulate values were likely caused by local traffic, nearby industrial sources and/or transport of wind-blown dust from outside of the city.

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Monitoring Method

The Alberta Environment Mobile Air Monitoring Laboratory (MAML) was used to monitor air quality for about 78 hours, over eight days, in Medicine Hat between May 1998 and January 1999. The focus of this monitoring was to collect air quality data representative of urban sources in the city, such as vehicle exhaust emissions and industrial sources. Air quality was monitored on the following dates representing the spring, summer, fall and winter seasons:

- spring (May 26 and 27, 1998)
- summer (August 26 and 27, 1998);
- fall (November 4 and 5, 1998); and
- winter (January 27 and 28, 1999).

The MAML monitored air quality at five locations in Medicine Hat for a minimum of one hour at each location to allow comparison to the air quality guidelines. Data collected at these locations was compared to a previous survey conducted in Medicine Hat in 1990 and to other locations in the province for the same time period.

An air quality monitoring study was conducted in Medicine Hat from January 10, 1990 to April 30, 1990. The monitoring station was located at the Medicine Hat Health Unit building at 770-1st Street S.E. The purpose of this study was to assess the city's general air quality over a three-month period. Parameters monitored included carbon monoxide, dust and smoke, oxides of nitrogen, ozone, sulphur dioxide, total hydrocarbons and total suspended particulates.

The MAML is a 27-foot (8.2 m) vehicle that has been specially designed and equipped to measure air quality. It houses a variety of instruments that continuously sample the air at specified time or distance intervals.

The MAML is equipped with:

- a dual computer system custom-programmed to control the measurement of air samples from each analyzer;
- a GPS (Global Positioning System) that will identify the MAML's location as it moves around Alberta;
- an exhaust purifying system that minimizes emissions from the vehicle; and
- two on-board generators that are also equipped with exhaust scrubbers.

The following parameters were measured by the MAML during the 1998/99 Medicine Hat survey:

- sulphur dioxide (SO_2);
- hydrogen sulphide (H_2S);
- total reduced sulphur (TRS);
- total hydrocarbons (THC);
- reactive hydrocarbons (RHC);
- polycyclic aromatic hydrocarbons (PAHs);
- methane (CH_4);
- ozone (O_3);
- nitrogen dioxide (NO_2);
- nitric oxide (NO);
- total oxides of nitrogen (NO_X);
- total suspended particulates (TSP);
- inhalable particulates (PM_{10});
- respirable particulates ($PM_{2.5}$);
- carbon monoxide (CO);
- ammonia (NH_3);
- wind direction and speed;
- temperature; and
- relative humidity.

★ Site #1 - Fair Grounds *(21 Ave. & 21 St. SE)*
★ Site #2 - Airport *(25 St. & 9 Ave. SW)*
★ Site #3 - Downtown *(S. Railway St. & 2 St. SE)*
★ Site #4 - Lions Park *(Woodman Ave. & 4 St. SE)*
★ Site #5 - Brier Industrial Park *(Brier Park Cres. & Brier Park Rd)*
★ Site #5a - Brier Industrial Park *(3 blocks N of Site #5 on Brier Park Place)*

◆ 1990 Monitoring site - Downtown *(770 - 1 St. SE)*

Location of Medicine Hat Monitoring Sites

Carbon Monoxide (CO)

max. one-hour concentration	one-hour guideline
2.8 ppm	13 ppm

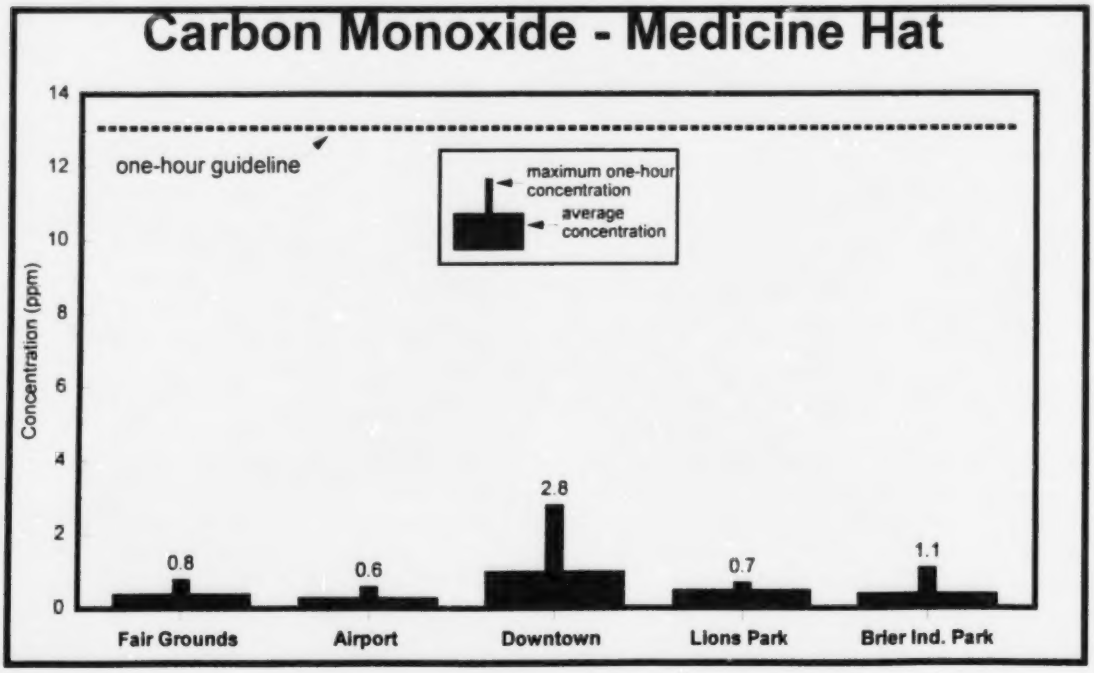
Carbon monoxide (CO) is a colourless, odourless gas emitted into the atmosphere primarily by motor vehicles. Minor sources include fireplaces, industry, aircraft and natural gas combustion. The major source of carbon monoxide in Medicine Hat is vehicle exhaust emissions.

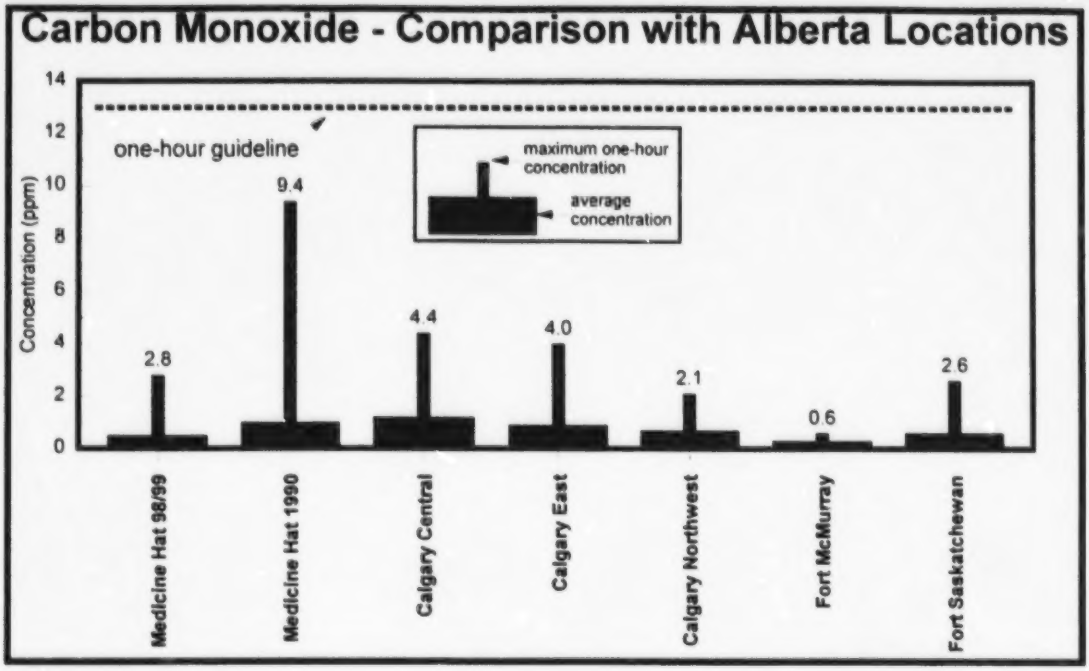
CO values were generally low during the entire survey period in the Medicine Hat area. The maximum one-hour concentration of 2.8 ppm was recorded at the downtown site in the afternoon of January 28. This maximum value is 22% of the one-hour guideline. CO was not monitored in Medicine Hat on November 5 due to an instrument malfunction.

The highest CO concentrations were measured in downtown Medicine Hat. Average concentrations for the entire monitoring period were 1.0 ppm at the downtown monitoring site compared to 0.3 to 0.5 ppm at the other four monitoring locations.

The average CO concentration at the downtown site was the same as the average CO concentration measured in downtown Medicine Hat during the 1990 survey (1.0 ppm). However, the maximum one-hour concentration in the 1990 survey (9.4 ppm) was substantially higher than the maximum one-hour value recorded in the 1998/99 survey (2.8 ppm). It should be noted that monitoring in 1990 was conducted on a continuous basis from January to April while the 1998/99 survey was conducted on eight days over a one-year period.

CO values measured in the 1998/99 survey were lower than those measured at the three monitoring stations located in Calgary for the same time period. The overall average CO concentration in the 1998/99 Medicine Hat survey was 0.5 ppm compared to 0.7 to 1.2 ppm recorded at the Calgary monitoring stations. Concentrations in Medicine Hat were similar to other smaller urban locations such as Fort McMurray and Fort Saskatchewan, where average CO levels for the same time period were 0.3 and 0.6 ppm, respectively. As mentioned earlier, the major source of CO in Medicine Hat is vehicle exhaust emissions.





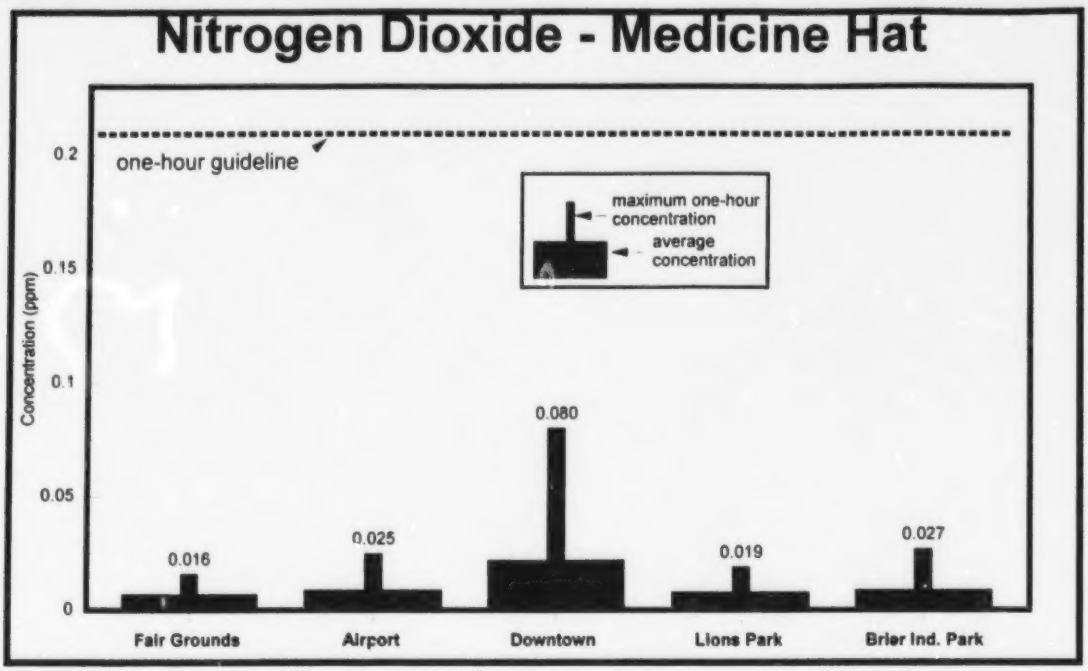
Oxides of Nitrogen (NO_2, NO, NO_x)

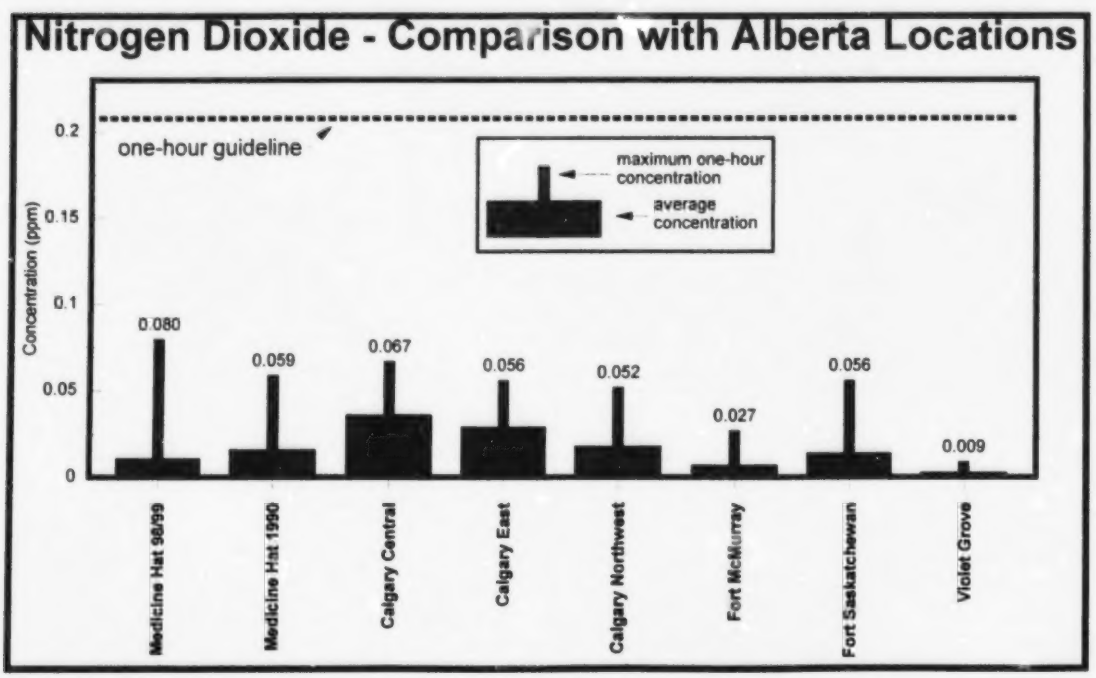
max. one-hour concentration	one-hour guideline
NO_2 = 0.080 ppm	0.210 ppm
NO = 0.108 ppm	no guideline
NO_x = 0.173 ppm	no guideline

Oxides of nitrogen (NO_x) are the total of nitrogen dioxide (NO_2) and nitric oxide (NO). During high temperature combustion - as in the burning of natural gas, coal, oil and gasoline - atmospheric nitrogen may combine with molecular oxygen to form NO. NO is colourless and odourless. Most NO in the ambient air is oxidized to form NO_2. NO_2 is a reddish-brown gas with a pungent odour. The major source of oxides of nitrogen in urban areas is vehicle exhaust emissions. Processes associated with the oil and gas industry also emit oxides of nitrogen into the atmosphere.

The maximum one-hour average NO_2 concentration (0.080 ppm) was recorded at the downtown site in the afternoon on November 5. The highest NO and NO_x concentrations (0.108 and 0.173 ppm) were also measured at this location and time. Concentrations of oxides of nitrogen were higher in downtown Medicine Hat than at the other four monitoring locations. The overall average NO_2 concentration at the downtown site was 0.021 ppm compared to between 0.007 and 0.009 ppm at the other four monitoring sites. The average NO_2 concentration at the downtown site in 1998/99 was also higher than the average value in the 1990 Medicine Hat survey (0.016 ppm). Higher NO_2 concentrations in downtown Medicine Hat may reflect an increase in automobile traffic.

Average oxides of nitrogen concentrations recorded in the 1998/99 Medicine Hat study were lower than those recorded in Calgary and close to those recorded at other smaller Alberta cities. The overall average NO_2 concentration in Medicine Hat was 0.011 ppm, compared to a range of 0.018 to 0.036 ppm at the three Calgary monitoring stations for the same time period. NO_2 values in Medicine Hat were similar to those measured in Fort McMurray (0.007 ppm) and Fort Saskatchewan (0.014 ppm) for the same time period. The primary source of oxides of nitrogen in Medicine Hat is vehicle exhaust emissions.


Nitrogen Dioxide - Medicine Hat
one-hour guideline
maximum one-hour concentration
average concentration
Concentration (ppm)
0.2
0.15
0.1
0.05
0
0.016
0.025
0.080
0.019
0.027
Fair Grounds
Airport
Downtown
Lions Park
Brier Ind. Park


Nitrogen Dioxide - Comparison with Alberta Locations
one-hour guideline
maximum one-hour concentration
average concentration
Concentration (ppm)
0.2
0.15
0.1
0.05
0
0.080
0.059
0.067
0.056
0.052
0.027
0.056
0.009
Medicine Hat 98/99
Medicine Hat 1990
Calgary Central
Calgary East
Calgary Northwest
Fort McMurray
Fort Saskatchewan
Violet Grove

Ozone (O_3)

max. one-hour concentration	one-hour guideline
0.062 ppm	0.082 ppm

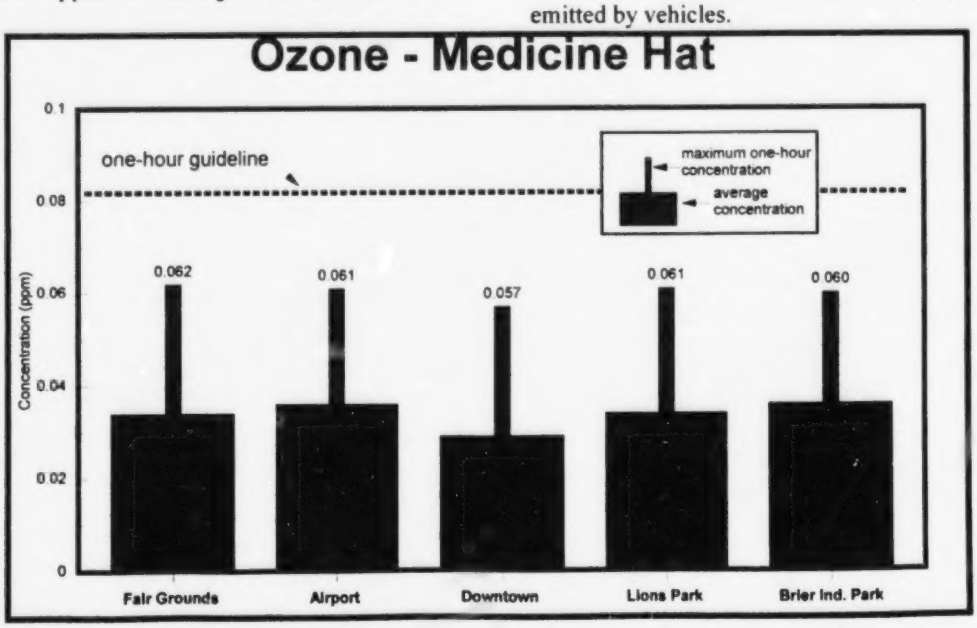
Ozone in the lower atmosphere is produced by: (1) the reaction of oxides of nitrogen and volatile organic compounds in the presence of sunlight, and (2) transport of O_3 from the upper atmosphere to ground level. Transport from the upper atmosphere is likely the dominant ozone producing process in the fall, winter and early spring seasons. O_3 concentrations are generally lower in urban centres due to the destruction of O_3 by nitric oxide.

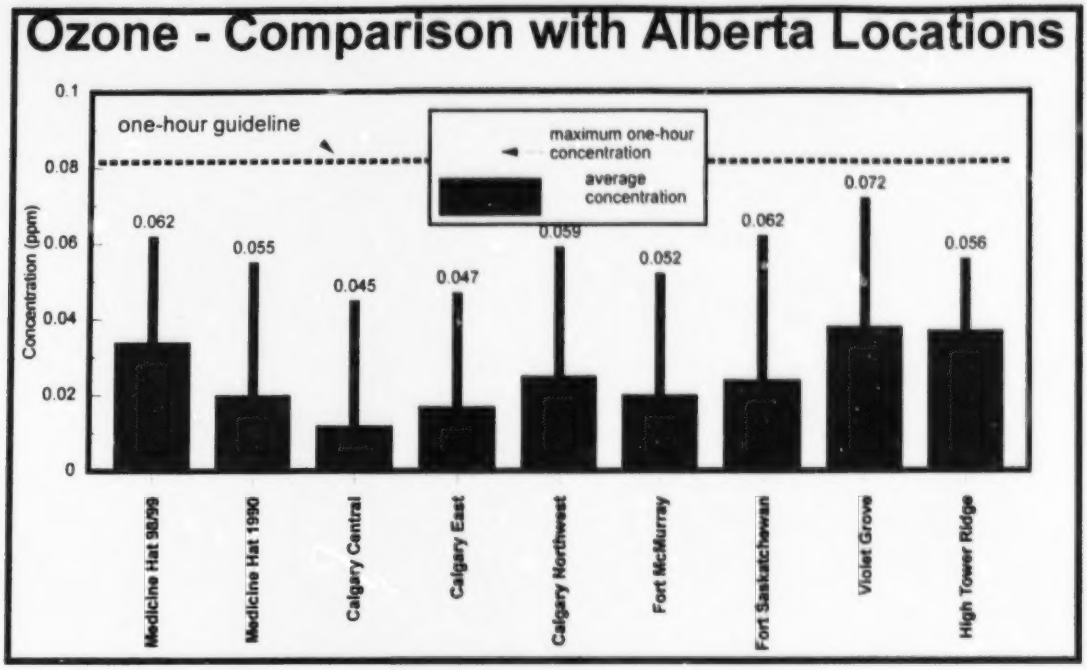
O_3 concentrations followed the typical daily and seasonal variations in Medicine Hat. Maximum concentrations were generally recorded in the late afternoon and in the spring and summer seasons. The maximum one-hour average O_3 concentration (0.062 ppm) was recorded in the afternoon of May 26 at the fair grounds monitoring site. Maximum one-hour O_3 concentrations between 0.055 and 0.060 ppm were also recorded in the afternoon on May 27 and August 26.

O_3 concentrations were lowest at the downtown site with an overall average value of 0.030 ppm. Average values at the other monitoring locations ranged from 0.034 to 0.036 ppm. Lower O_3 values in downtown Medicine Hat were due to the destruction of natural O_3 by nitric oxide contained in vehicle exhaust emissions.

O_3 levels in the 1998/99 survey were generally higher than in the air quality survey conducted in Medicine Hat in 1990. The average O_3 concentration in the 1990 survey was 0.020 ppm, compared to 0.034 ppm in the 1998/99 survey. This difference in O_3 concentrations is likely due to monitoring during different times of the year. The 1990 survey was conducted in the winter and early spring when O_3 levels are generally lower. The 1998/99 survey took place in two days representing each of the four seasons over the period of one year.

O_3 concentrations in Medicine Hat were similar to those recorded at rural locations in Alberta. The average O_3 value in the Medicine Hat area was 0.034 ppm, which is slightly lower than values recorded at the Violet Grove (located 10 km southwest of Drayton Valley) and High Tower Ridge (located 65 km west-northwest of Hinton) monitoring stations. Average O_3 values at these two stations was 0.038 and 0.037 ppm, respectively, for the same monitoring period. However, O_3 values in the Medicine Hat area were higher than those recorded at the Alberta Environment stations located in Calgary, Fort McMurray and Fort Saskatchewan where concentrations ranged from 0.012 to 0.025 ppm for the same time period. As mentioned earlier, O_3 concentrations are generally lower at urban locations because of the destruction of natural O_3 by nitric oxide emitted by vehicles.





Particulates (TSP, PM_{10} and $PM_{2.5}$)

max. one-hour concentration	one-hour guideline
TSP = 213 µg/m^3	no guideline
PM_{10} = 135 µg/m^3	no guideline
$PM_{2.5}$ = 12 µg/m^3	no guideline

Air pollutants are not necessarily in a gaseous form. Tiny particles of solid material or liquid droplets, defined collectively as particulates are also present in the atmosphere. Total suspended particulates (TSP) refer to all particles up to 500 microns in diameter (a human hair is about 100 microns in diameter) and are important primarily from a nuisance perspective. Particles less than 10 microns in diameter (PM_{10}) can be inhaled into the nose and throat while smaller particles, less than 2.5 microns in diameter ($PM_{2.5}$), can penetrate into the lungs. Sources of particulates include soil dust, road dust, agricultural dust (e.g., harvest), smoke from forest fires and recreational wood burning, vehicle exhaust emissions, brake and tire wear, and industrial emissions. Smaller particles ($PM_{2.5}$) originate in the atmosphere because of condensation and combustion from sources such as vehicle exhaust emissions, industrial emissions and wood burning.

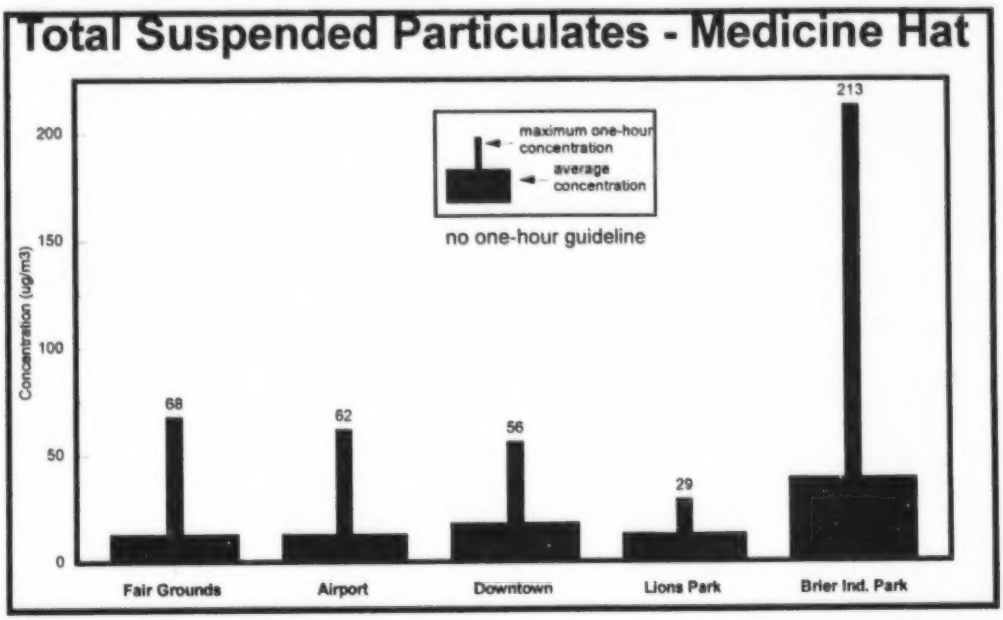
The highest one-hour average particulate concentrations were observed at the Brier Industrial Park from 12:15 to 1:15 p.m on November 5. TSP, PM_{10} and $PM_{2.5}$ concentrations were 213, 135 and 12 µg/m^3, respectively, during this one-hour time period. Elevated particulate concentrations were also recorded at the Brier Industrial Park monitoring site from 11:40 a.m. to 12:50 p.m. on November 4. TSP, PM_{10} and $PM_{2.5}$ concentrations were 157, 92 and 8 µg/m^3, respectively, during this time period. Elevated particulate levels at this location may have been caused by local traffic, nearby industrial sources, and/or transport of wind-blown dust from outside the city. The source of these elevated particulate values could not be determined at the time of monitoring.

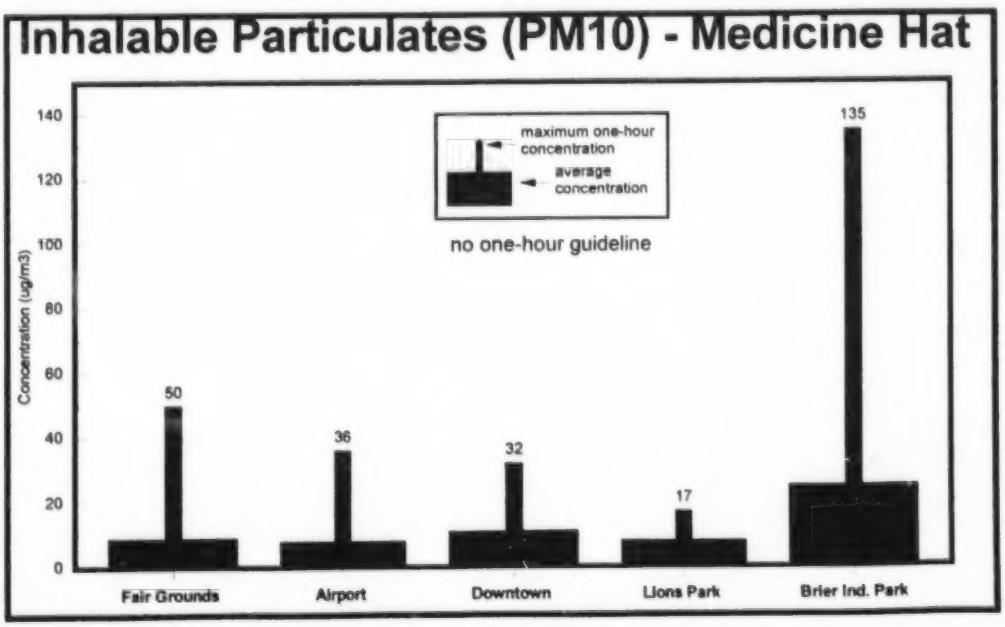
TSP and PM_{10} levels were highest at Brier Industrial Park, with average concentrations of 39 and 25 µg/m^3, respectively, for the entire monitoring period. The second highest overall average TSP and PM_{10} concentrations were recorded at the downtown site where average values of 19 and 12 µg/m^3 were recorded, respectively. Average $PM_{2.5}$ concentrations were fairly uniform at all five monitoring sites, with average values between 2 and 3 µg/m^3.

The overall average TSP concentration in the 1998/99 study was substantially lower than the average value recorded from January to April in 1990 in downtown Medicine Hat. The average TSP concentration (based on

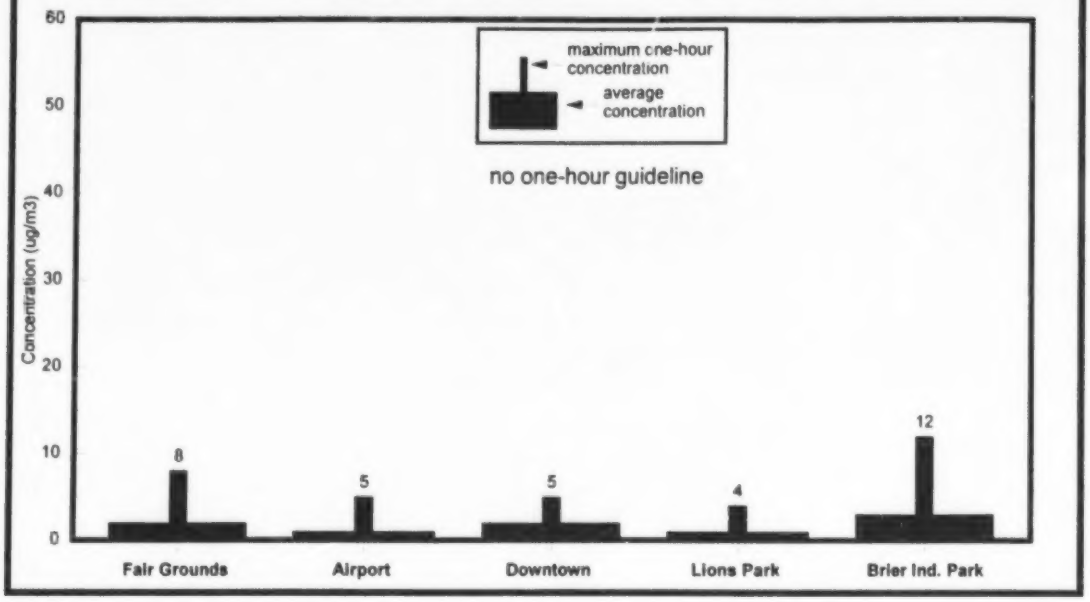
samples taken every 6th day according to the National Air Pollution Surveillance system) was 82 $\mu g/m^3$ in 1990, compared to 28 $\mu g/m^3$ at the downtown site in the 1998/99 survey. PM_{10} and $PM_{2.5}$ were not monitored in the 1990 survey.

Average PM_{10} and $PM_{2.5}$ levels in the 1998/99 Medicine Hat survey were lower than those recorded at other Alberta monitoring stations for the same time period. The overall average PM_{10} concentration recorded in Medicine Hat was 13 $\mu g/m^3$ (based on data from all five monitoring sites), compared to 41 $\mu g/m^3$ at the Calgary Central monitoring station. The overall average $PM_{2.5}$ concentration was 2 $\mu g/m^3$ in Medicine Hat, compared to 16 $\mu g/m^3$ at the Calgary Central station and 8 $\mu g/m^3$ at the Fort McMurray monitoring station for the same time period.

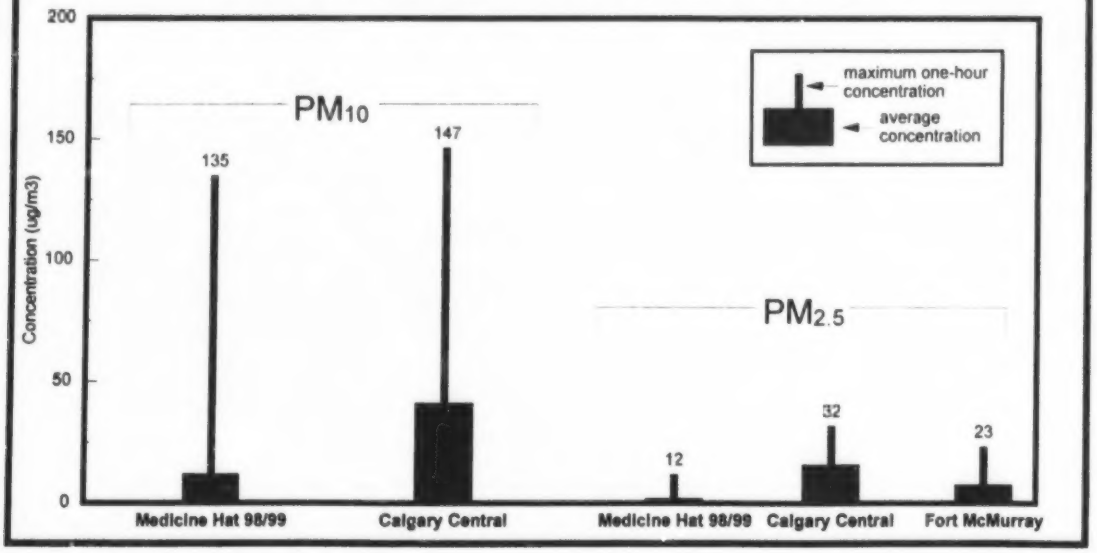




Respirable Particulates (PM2.5) - Medicine Hat



Inhalable (PM10) and Respirable (PM2.5) Particulates Comparison with Alberta Locations



Hydrocarbons (THC, RHC and CH_4)

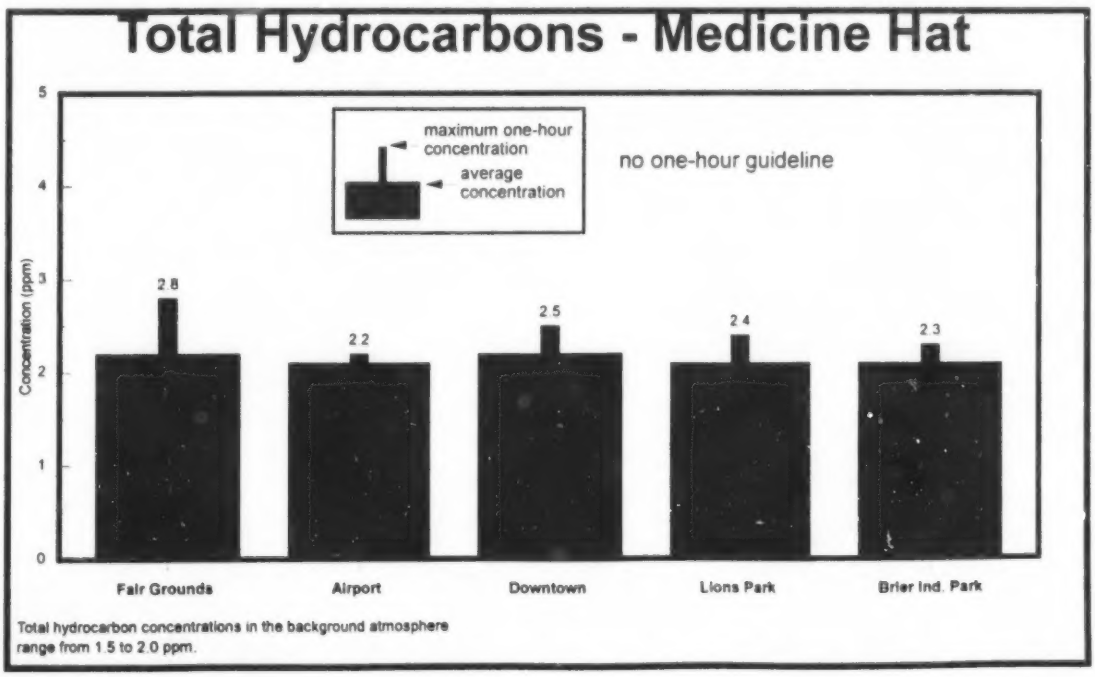
max. one-hour concentration	one-hour guideline
THC = 2.6 ppm	no guideline
RHC = 0.4 ppm	no guideline
CH_4 = 2.3 ppm	no guideline

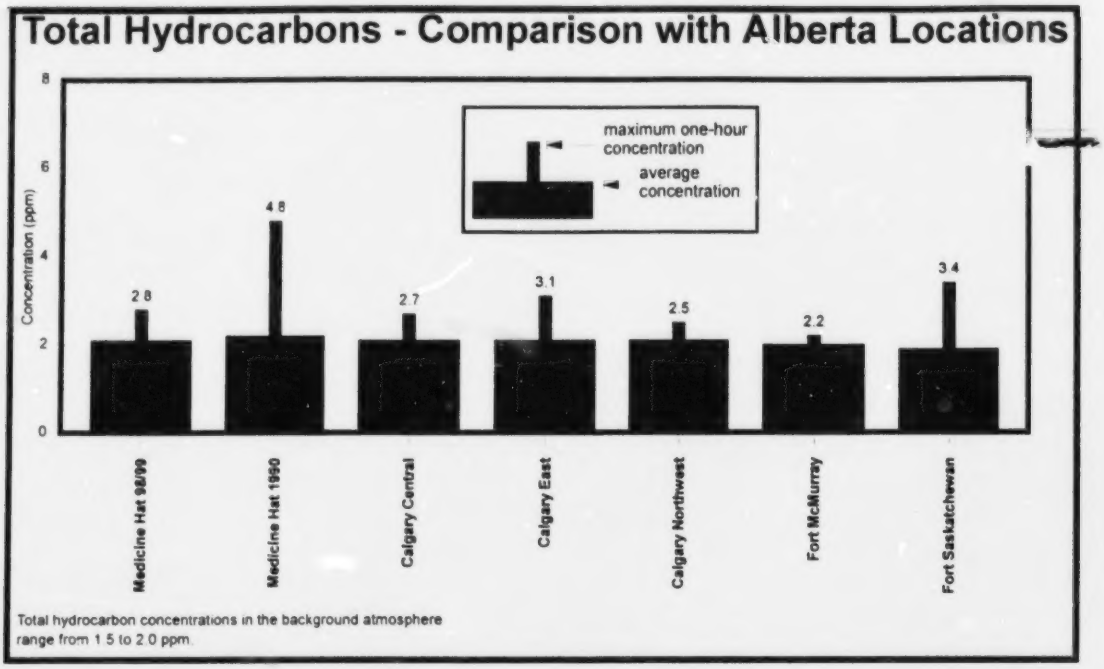
The term "total hydrocarbons" (THC) refers to a broad family of chemicals that contain carbon and hydrogen atoms. Methane (CH_4), a non-reactive hydrocarbon, is the most common hydrocarbon in the earth's atmosphere. Specific reactive hydrocarbons (RHC) are important because: (1) they can react with oxides of nitrogen in the presence of sunlight to form ozone; and (2) they can be toxic (at high concentrations) to humans, animals or vegetation. Sources of hydrocarbons include vegetation, vehicle emissions, gasoline marketing and storage tanks, petroleum and chemical industries, dry cleaning, fireplaces, natural gas combustion and aircraft traffic.

Hydrocarbon levels were generally close to background levels in the Medicine Hat area during the monitoring period. Slightly elevated THC concentrations were measured at the fair grounds monitoring site in the morning of August 27 (6:40 to 7:40 a.m.) and in the morning of November 4 (8:10 to 9:10 a.m.). One-hour THC concentrations of 2.6 ppm were recorded during these time periods.

Overall average hydrocarbon concentrations were consistent at all five monitoring sites in Medicine Hat. The average THC concentrations at all sites were between 2.1 and 2.2 ppm. Average reactive hydrocarbon (RHC) concentrations were in the 0.1 to 0.2 ppm range at all five monitoring sites for the entire monitoring period.

Hydrocarbon concentrations in the 1998/99 Medicine Hat study were close to those recorded in the 1990 Medicine Hat study and also similar to hydrocarbon values at other monitoring locations in Alberta. The overall average THC concentration in the 1998/99 Medicine Hat study was 2.1 ppm, compared to 2.2 ppm measured in downtown Medicine Hat during the 1990 study. THC values for the same monitoring period in Calgary, Fort Saskatchewan and Fort McMurray ranged from 1.9 ppm at the Fort Saskatchewan station to 2.1 ppm at all three Calgary monitoring stations. Normal background THC concentrations range from 1.5 to 2.0 ppm.





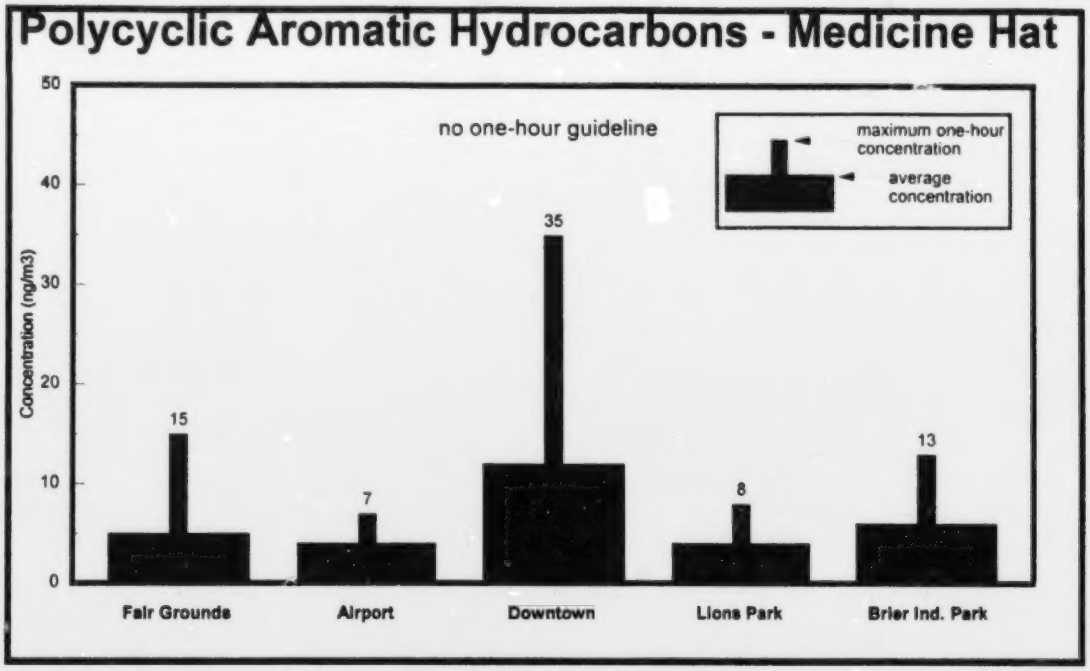
Polycyclic Aromatic Hydrocarbons (PAHs)

max. one-hour concentration	one-hour guideline
35 ng/m^3	no guideline

Polycyclic aromatic hydrocarbons (PAHs) are a class of chemicals that are contained in soot and smoke. There are more than 100 different PAHs with varying levels of toxicity. They are formed during the incomplete combustion of gasoline, diesel, oil, coal, wood, garbage or other organic substances. Tobacco smoke and charbroiled meats are common sources of PAHs. Other outdoor PAH sources include vehicle exhaust emissions, wood smoke from fireplaces, smoke from forest fires and industrial facilities. PAHs occur in the atmosphere in the vapour phase or attached to dust particles. The PAH monitoring instrument aboard the MAML will analyze only particulate bound PAHs.

The highest one-hour average PAH concentration was recorded at the downtown site from 4:01 to 5:02 p.m. on January 28 with a value of 35 ng/m^3 (nanograms per cubic metre). Based on averages for the entire monitoring period, PAH levels were highest in downtown Medicine Hat, with an average concentration of 12 ng/m^3. Average PAH concentrations ranged from 4 to 6 ng/m^3 at the other four monitoring sites. Slightly elevated PAH values were recorded in downtown Medicine Hat because of vehicle exhaust emissions.

Alberta does not have ambient air quality guidelines for total PAHs. However, the maximum one-hour PAH concentration of 35 ng/m^3 was much lower than the NIOSH (U.S. Department of Health and Human Services National Institute for Occupational Safety and Health) maximum permissible exposure level for total PAHs (100,000 ng/m^3 for a 10 hour exposure period). PAHs are not routinely monitored on an hourly basis at other locations in Alberta. However, PAHs are monitored as a 24-hour concentration at several locations in the province.



Sulphur Dioxide (SO_2)

max. one-hour concentration	one-hour guideline
0.029 ppm	0.170 ppm

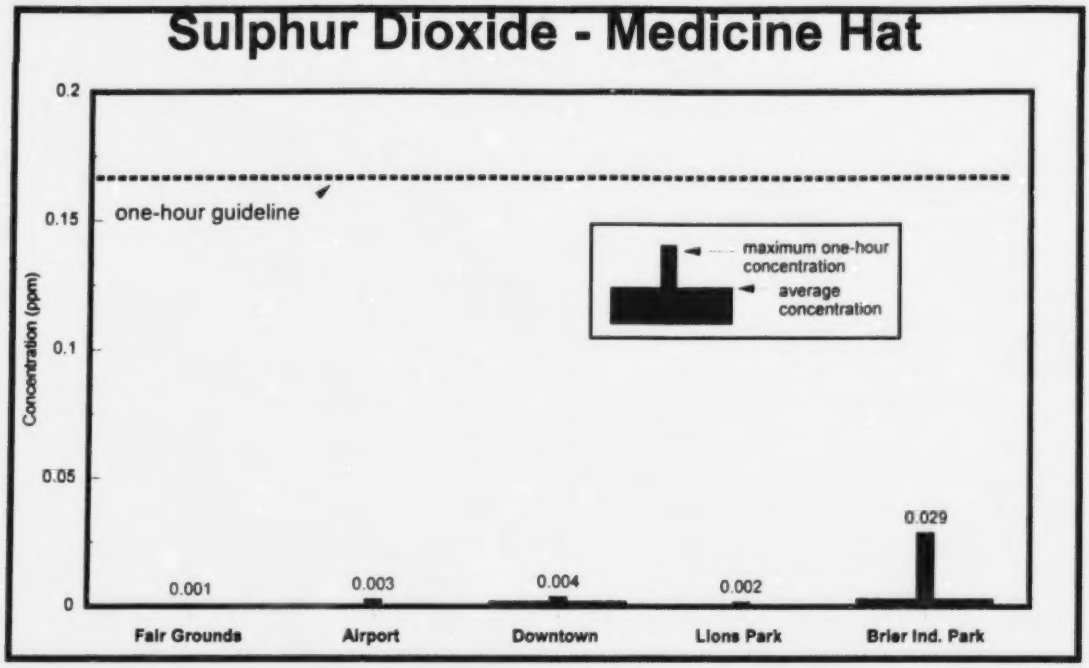
Sulphur dioxide (SO_2) is a colourless gas with a pungent odour. In Alberta, the major sources of SO_2 are natural gas processing plants, oil sands facilities, and power plants. Other sources include gas plant flares, oil refineries, pulp and paper mills and fertilizer plants.

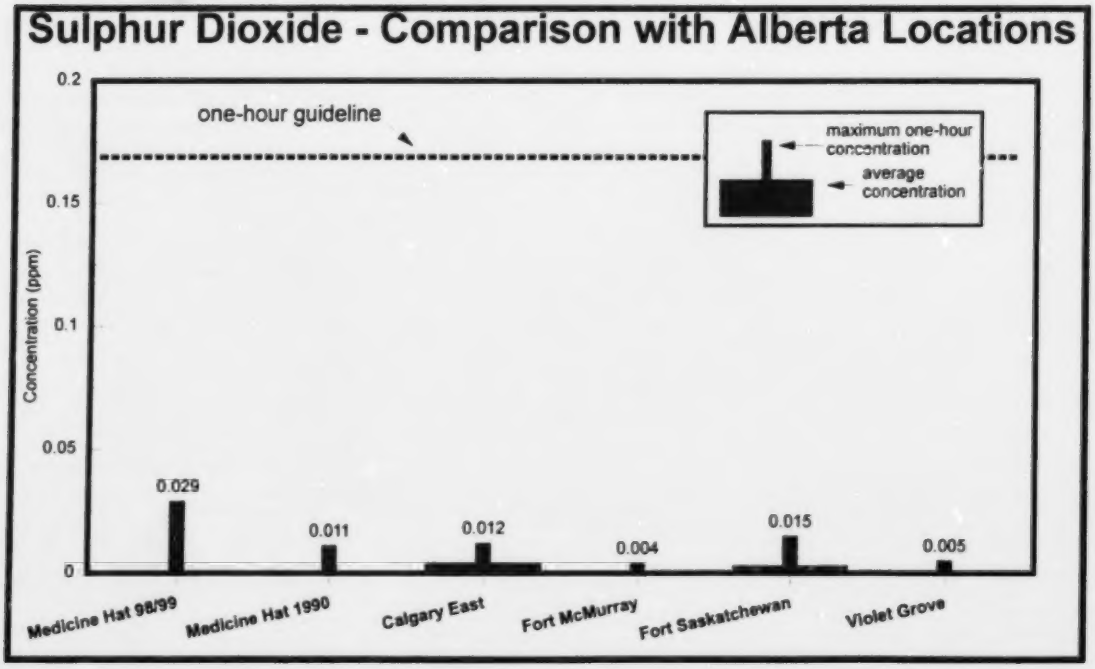
An elevated SO_2 concentration was recorded at the Brier Industrial Park monitoring site (#5a) from 12:20 to 1:20 p.m. on January 28, 1999. The average concentration recorded during this time period (0.029 ppm) was 17% of the one-hour guideline for SO_2. The five-minute peak concentration recorded at this time was 0.056 ppm. Winds were from the south-southwest at 27 km/h when this elevated value was recorded. This elevated SO_2 reading was likely due to an industrial facility immediately upwind of the MAML.

A slightly elevated peak five-minute SO_2 concentration of 0.023 ppm was also recorded at the downtown site in the late afternoon on November 5. The one-hour average concentration during this time was 0.004 ppm. Winds were from the southeast and east-southeast directions at 9 km/h when this elevated SO_2 concentration was measured. The source of this brief elevated concentration could not be determined at the time of monitoring.

SO_2 concentrations were very low for the remainder of the monitoring period, with one-hour concentrations less than 0.004 ppm. Maximum one-hour and peak five-minute SO_2 concentrations in Medicine Hat were below Alberta's one-hour guideline of 0.170 ppm.

The overall average SO_2 concentration for the entire monitoring period in the 1998/99 Medicine Hat survey was 0.001 ppm. This is the same as the average concentration recorded in downtown Medicine Hat during the 1990 monitoring survey. The overall average SO_2 concentration in Medicine Hat was lower than average values recorded at the Calgary East (0.004 ppm) and Fort Saskatchewan (0.003 ppm) monitoring stations. However, the maximum one-hour SO_2 concentration in Medicine Hat (0.029 ppm) was higher than maximum values recorded at the Calgary East (0.012 ppm) and Fort Saskatchewan (0.015 ppm) stations. Higher maximum one-hour SO_2 values recorded by the MAML in Medicine Hat were due to monitoring in close proximity and directly downwind of industrial facilities in the Brier Industrial Park.


Sulphur Dioxide - Medicine Hat
0.2
0.15
0.1
0.05
0
Concentration (ppm)
one-hour guideline
maximum one-hour concentration
average concentration
0.001
0.003
0.004
0.002
0.029
Fair Grounds
Airport
Downtown
Lions Park
Brier Ind. Park


Sulphur Dioxide - Comparison with Alberta Locations
0.2
0.15
0.1
0.05
0
Concentration (ppm)
one-hour guideline
maximum one-hour concentration
average concentration
0.029
0.011
0.012
0.004
0.015
0.005
Medicine Hat 98/99
Medicine Hat 1990
Calgary East
Fort McMurray
Fort Saskatchewan
Violet Grove

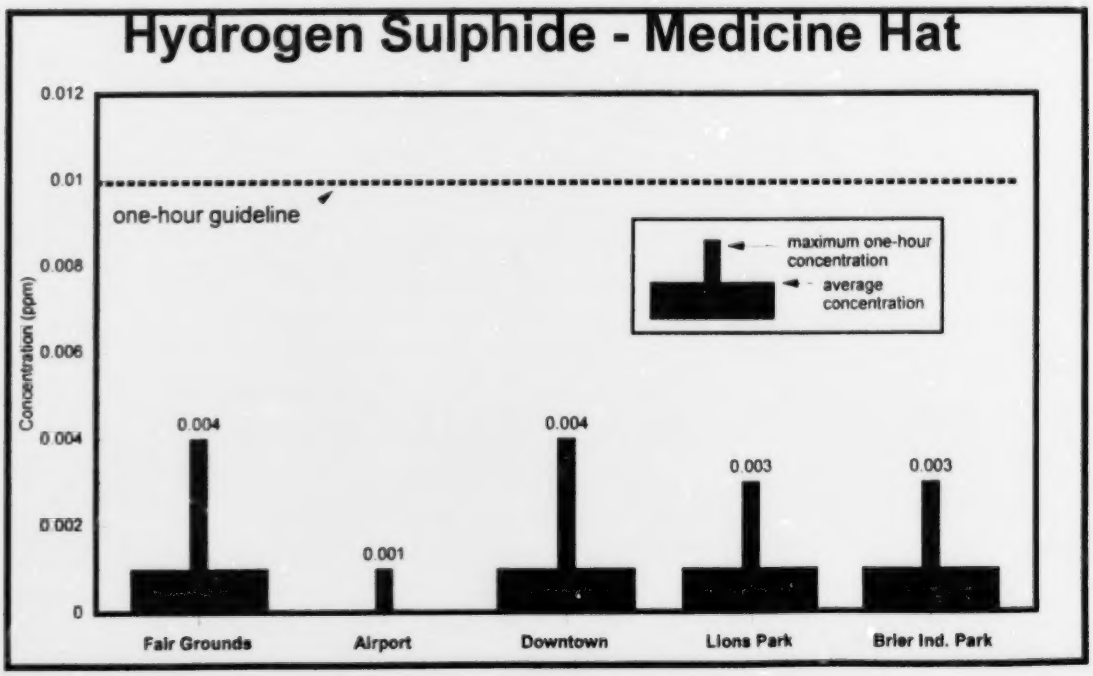
Hydrogen Sulphide and Total Reduced Sulphur (H_2S and TRS)

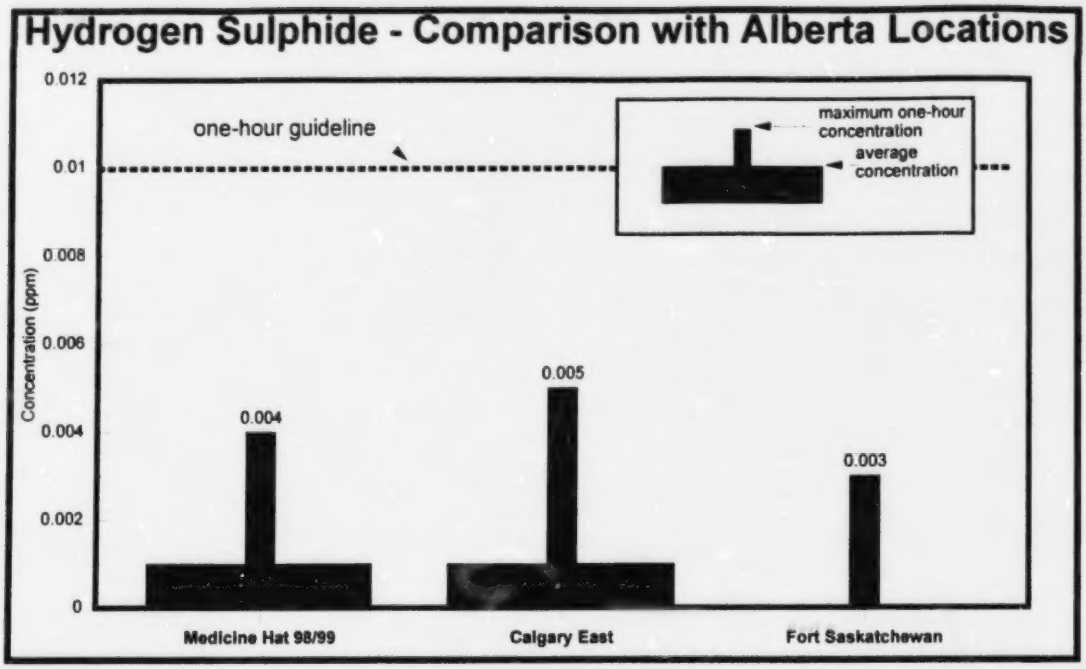
max. one-hour concentration	one-hour guideline
H_2S = 0.004 ppm TRS = 0.001 ppm	0.010 ppm no guideline

Hydrogen sulphide (H_2S) is a colourless gas with a rotten egg odour. Total reduced sulphur (TRS) includes hydrogen sulphide, mercaptans, dimethyl sulphide, dimethyl disulphide and other sulphur compounds. Sulphur dioxide is not included in the determination of TRS. Industrial sources of H_2S and TRS include fugitive emissions (leakages) from petroleum refineries, tank farms for unrefined petroleum products, natural gas plants, petrochemical plants, oil sands plants, sewage treatment facilities, pulp and paper plants that use the Kraft pulping process, and animal feedlots. Natural sources of H_2S include sulphur hot springs, sloughs, swamps and lakes.

H_2S and TRS concentrations were at or below the detection limit of the monitoring instrument most of the time during the Medicine Hat survey. The maximum one-hour concentration of 0.004 ppm was recorded on the morning of November 5 at the fair grounds and downtown monitoring sites. This value is 40% of the one-hour guideline for H_2S. Peak five-minute concentrations at these two locations were 0.006 and 0.007 ppm, respectively. These slightly elevated values may have been caused by train operations and traffic in the area. One-hour average H_2S concentrations were 0.003 ppm or less for the remainder of the monitoring period.

H_2S and TRS were not monitored in the 1990 Medicine Hat survey. The overall average H_2S concentration in the 1998/99 Medicine Hat survey (0.001 ppm) was close to average values recorded at the Calgary East (0.001 ppm) and Fort Saskatchewan (0.000 ppm) monitoring stations over the same monitoring period. The maximum one-hour average H_2S concentration in Medicine Hat (0.004 ppm) was also close to maximum values recorded at the Calgary East (0.005 ppm) and Fort Saskatchewan (0.003 ppm) stations. The overall average and maximum one-hour TRS concentrations in Medicine Hat were 0.000 and 0.001 ppm, respectively. TRS is not routinely monitored at Alberta Environment monitoring stations.





Ammonia (NH_3)

max. one-hour concentration	one-hour guideline
0.027 ppm	2.0 ppm

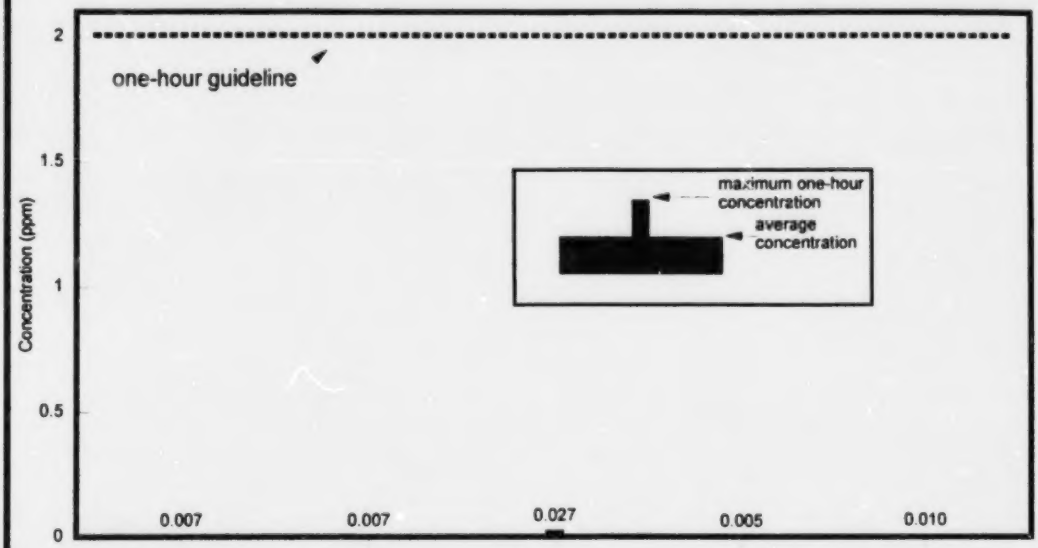
Ammonia is a colourless gas with the well-known pungent odour found in household cleaners. NH_3 is produced both by natural and man-made sources. Some natural sources of NH_3 include the decay of plant material and animal waste. A small portion is also released during respiration. In Alberta, the fertilizer industry is the main industrial source of NH_3. The industry produces synthetic NH_3 for either direct application to soil as a fertilizer, or as a raw material for use in the production of other high nitrogen fertilizer products. The other major source of NH_3 is commercial feedlots, specifically from their large amounts of animal waste.

NH_3 levels were very low during the Medicine Hat survey. The highest one-hour average NH_3 concentration (0.027 ppm) was measured at the downtown site from 5 to 6 p.m. on November 5. The one-hour average concentration recorded during this time period (0.027 ppm) was 1% of the one-hour guideline for ammonia (2.0 ppm). One-hour average NH_3 concentrations greater than 0.020 ppm were also recorded at the downtown site on May 26.

Average NH_3 levels were substantially higher at the downtown site than at the other five monitoring locations. The overall average concentration at the downtown site was 0.010 ppm, compared to between 0.002 and 0.004 ppm at the other four monitoring sites. Higher NH_3 values in downtown Medicine Hat were likely caused by vehicle exhaust emissions.

Average and maximum one-hour NH_3 values in the Medicine Hat survey were 0.004 and 0.027 ppm, respectively. These values are very close to average (0.005 ppm) and maximum (0.024 ppm) concentrations recorded at the Fort Saskatchewan station for the same time period. NH_3 is not continuously monitored by Alberta Environment at any other monitoring stations.

Ammonia - Medicine Hat



Ammonia - Comparison with Alberta Locations

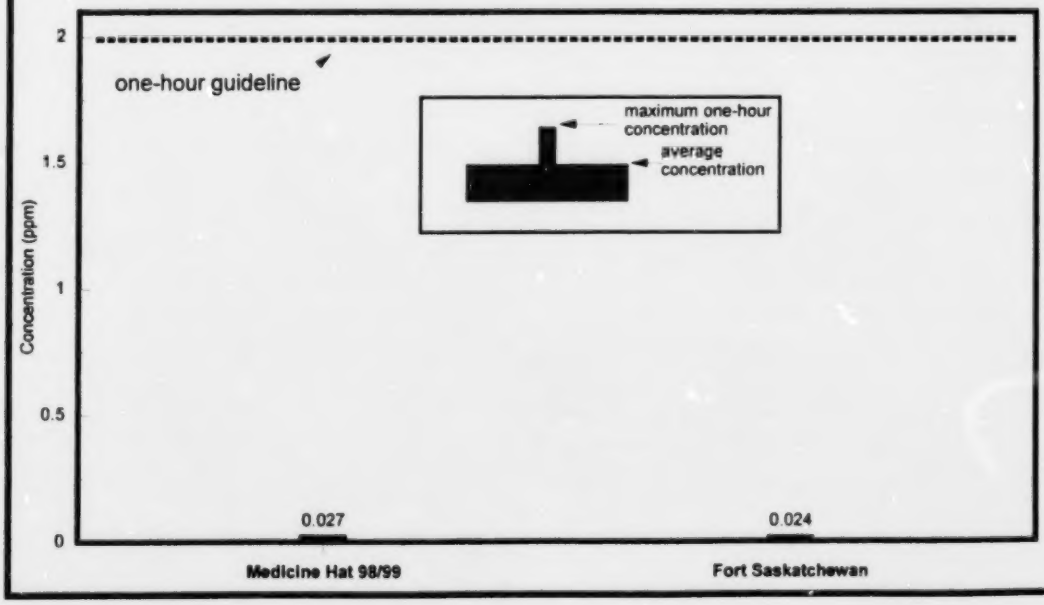


Table 1 shows **overall average** air quality parameter concentrations at individual monitoring locations in Medicine Hat

Table 1: Overall Average Air Quality Parameter Concentrations at each Site in Medicine Hat

Monitoring Location	CO (ppm)	O_3 (ppm)	THC (ppm)	CH_4 (ppm)	RHC (ppm)	SO_2 (ppm)	NO (ppm)	NO_2 (ppm)	NO_x (ppm)	NH_3 (ppm)	H_2S (ppm)	TRS (ppm)	PAH (ng/m^3)	TSP (ug/m^3)	PM_{10} (ug/m^3)	$PM_{2.5}$ ($\mu g/m^3$)
Fair grounds	0.4	0.034	2.1	1.8	0.2	0.001	0.004	0.007	0.012	0.002	0.001	0.000	5	19	13	2
Airport	0.3	0.036	2.1	1.8	0.1	0.001	0.004	0.009	0.013	0.003	0.000	0.000	4	17	11	2
Downtown	1.0	0.030	2.2	1.8	0.2	0.002	0.025	0.021	0.045	0.010	0.001	0.001	12	28	18	3
Lions Park	0.5	0.036	2.1	1.8	0.2	0.001	0.003	0.008	0.011	0.002	0.001	0.000	4	18	11	2
Brier Industrial Park	0.4	0.036	2.1	1.8	0.2	0.003	0.004	0.009	0.013	0.004	0.001	0.000	6	39	25	3
Overall Average	0.5	0.034	2.1	1.8	0.2	0.001	0.008	0.011	0.019	0.004	0.001	0.000	6	24	15	2

Table 2 shows **maximum one-hour** air quality parameter concentrations at individual monitoring locations in Medicine Hat

Table 2: Maximum One-hour Air Quality Parameter Concentrations at each Site in Medicine Hat

Monitoring Location	CO (ppm)	O_3 (ppm)	THC (ppm)	CH_4 (ppm)	RHC (ppm)	SO_2 (ppm)	NO (ppm)	NO_2 (ppm)	NO_x (ppm)	NH_3 (ppm)	H_2S (ppm)	TRS (ppm)	PAH (ng/m^3)	TSP (ug/m^3)	PM_{10} (ug/m^3)	$PM_{2.5}$ ($\mu g/m^3$)
Fair grounds	0.8	0.062	2.6	2.3	0.3	0.001	0.027	0.016	0.038	0.007	0.004	0.001	15	68	50	8
Airport	0.6	0.061	2.2	1.9	0.2	0.003	0.014	0.025	0.029	0.007	0.001	0.001	7	62	36	5
Downtown	2.8	0.057	2.5	2.1	0.4	0.004	0.108	0.080	0.173	0.027	0.004	0.001	35	56	32	5
Lions Park	0.7	0.055	2.4	2.2	0.2	0.002	0.014	0.018	0.027	0.005	0.003	0.001	8	29	17	4
Brier Industrial Park	1.1	0.060	2.3	2.0	0.3	0.029	0.014	0.027	0.037	0.010	0.003	0.001	13	213	135	12
One-Hour Maximum	2.8	0.062	2.6	2.3	0.4	0.029	0.108	0.080	0.173	0.027	0.004	0.001	35	213	135	12
One-Hour Guideline	13.0	0.082	n/a	n/a	n/a	0.170	n/a	0.210	n/a	2.0	0.010	n/a	n/a	n/a	n/a	n/a

n/a No one hour guideline

Table 3 shows **peak five-minute** air quality parameter concentrations at individual monitoring locations in Medicine Hat

Table 3: Peak Five-Minute Air Quality Parameter Concentrations at each Site in Medicine Hat

Monitoring Location	CO (ppm)	O_3 (ppm)	THC (ppm)	CH_4 (ppm)	RHC (ppm)	SO_2 (ppm)	NO (ppm)	NO_2 (ppm)	NO_x (ppm)	NH_3 (ppm)	H_2S (ppm)	TRS (ppm)	PAH (ng/m^3)	TSP (ug/m^3)	PM_{10} (ug/m^3)	$PM_{2.5}$ ($\mu g/m^3$)
Fair grounds	1.0	0.064	2.9	2.5	0.8	0.002	0.029	0.021	0.041	0.010	0.006	0.001	20	82	60	10
Airport	1.0	0.063	2.5	2.0	0.5	0.004	0.029	0.032	0.061	0.029	0.002	0.001	19	127	68	7
Downtown	5.7	0.060	3.1	2.1	0.9	0.023	0.419	0.492	0.778	0.201	0.007	0.002	82	221	122	14
Lions Park	1.5	0.063	3.5	2.5	1.4	0.003	0.018	0.031	0.043	0.010	0.004	0.001	21	92	50	4
Brier Industrial Park	3.1	0.062	2.7	2.3	0.5	0.056	0.027	0.032	0.058	0.017	0.004	0.004	33	880	542	53
Five-Minute Peak	5.7	0.064	3.5	2.5	1.4	0.056	0.419	0.492	0.778	0.201	0.007	0.004	82	880	542	53

Table 4 shows **overall average** air quality parameter concentrations at all monitoring locations in Medicine Hat for the entire monitoring period compared with other locations in Alberta.

Table 4: Overall Average Air Quality Parameter Concentrations at Other Locations in Alberta

Monitoring Location	CO (ppm)	O_3 (ppm)	THC (ppm)	CH_4 (ppm)	RHC (ppm)	SO_2 (ppm)	NO (ppm)	NO_2 (ppm)	NO_X (ppm)	NH_3 (ppm)	H_2S (ppm)	TRS (ppm)	PAH (ng/m^3)	TSP (ug/m^3)	PM_{10} (ug/m^3)	$PM_{2.5}$ ($\mu g/m^3$)
Medicine Hat 1998/99	0.5	0.034	2.1	1.8	0.2	0.001	0.009	0.011	0.019	0.004	0.001	0.000	7	28	18	3
Medicine Hat 1990	1.0	0.020	2.2	no data		0.001	0.019	0.016	0.035	no data				82*	no data	
Calgary Central	1.2	0.012	2.1	no data			0.040	0.036	0.075	no data					41	16
Calgary East	0.9	0.017	2.1	no data		0.004	0.060	0.029	0.090	no data	0.001			no data		
Calgary Northwest	0.7	0.025	2.1	no data			0.012	0.018	0.030	no data						
Fort McMurray	0.3	0.020	2.0	no data		0.000	0.005	0.007	0.012	no data		0.000		no data		8
Fort Saskatchwan	0.6	0.024	1.9	no data		0.003	0.022	0.014	0.036	0.005	0.000			no data		
Violet Grove ***	no data	0.038	no data	2.0	0.2**	0.001	0.000	0.003	0.004	no data						
High Tower Ridge ****	no data	0.037	no data													

* Based on samples collected as a 24-hour concentration once every 6th day according to the National Air Pollution Surveillance schedule

** Reported as non-methane hydrocarbons

*** The Violet Grove station is operated by the West Central Airshed Society and located 10 km southwest of Drayton Valley

**** The High Tower Ridge station is operated by the West Central Airshed Society and located 65 km west-northwest of Hinton

Table 5 shows **maximum one-hour** air quality parameter concentrations at all monitoring locations in Medicine Hat for the entire monitoring period compared with other locations in Alberta.

Table 5: Maximum One-Hour Average Air Quality Parameter Concentrations at Other Locations in Alberta

Monitoring Location	CO (ppm)	O_3 (ppm)	THC (ppm)	CH_4 (ppm)	RHC (ppm)	SO_2 (ppm)	NO (ppm)	NO_2 (ppm)	NO_X (ppm)	NH_3 (ppm)	H_2S (ppm)	TRS (ppm)	PAH (ng/m^3)	TSP (ug/m^3)	PM_{10} (ug/m^3)	$PM_{2.5}$ ($\mu g/m^3$)
Medicine Hat 1998/99	2.8	0.062	2.8	2.3	0.6	0.029	0.108	0.080	0.173	0.027	0.004	0.001	35	213	135	12
Medicine Hat 1990	9.4	0.055	4.8	no data		0.011	0.268	0.059	0.305				no data			
Calgary Central	4.4	0.045	2.7	no data			0.310	0.067	0.365	no data					147	32
Calgary East	4.0	0.047	3.1	no data		0.012	0.400	0.056	0.454	no data	0.005			no data		
Calgary Northwest	2.1	0.059	2.5	no data			0.099	0.052	0.134	no data						
Fort McMurray	0.6	0.052	2.2	no data		0.004	0.025	0.027	0.037	no data		0.001		no data		23
Fort Saskatchwan	2.6	0.062	3.4	no data		0.015	0.210	0.056	0.264	0.024	0.003			no data		
Violet Grove ***	no data	0.072	no data	2.5	4.6**	0.005	0.005	0.009	0.011	no data			no data			
High Tower Ridge ****	no data	0.056														
One-Hour Guidline	13.0	0.082	n/a	n/a	n/a	0.170	n/a	0.210	n/a	2.0	0.010	n/a	n/a	n/a	n/a	n/a

n/a No one hour guideline

** Reported as non-methane hydrocarbons

*** The Violet Grove station is operated by the West Central Airshed Society and located 10 km southwest of Drayton Valley

**** The High Tower Ridge station is operated by the West Central Airshed Society and located 65 km west-northwest of Hinton

Table 6 shows one-hour average air quality parameter concentrations and weather conditions on May and August survey days at each monitoring location in Medicine Hat.

Table 6: One-hour Average Air Quality Parameter Concentrations and Weather Conditions at Each Monitoring Site in Medicine Hat (May 26 and 27, and August 26 and 27, 1998)

Monitoring Location	Date	Time (MST)	CO (ppm)	O_3 (ppm)	THC (ppm)	CH_4 (ppm)	RHC (ppm)	SO_2 (ppm)	NO (ppm)	NO_2 (ppm)	NO_x (ppm)	NH_3 (ppm)	H_2S (ppm)	TRS (ppm)	PAH (ng/m^3)	TSP ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	$PM_{2.5}$ ($\mu g/m^3$)	Temp (Deg C)	WSP (km/h)	WDR
Fair grounds	26-May-98	07:12 to 08:15	0.4	0.036	2.1	1.8	0.2	0.000	no data				0.000	no data	4		no data		20	13	E
Airport		08:43 to 09:44	0.5	0.043	2.0	1.7	0.2	0.000	0.003	0.011	0.013	0.000	0.000	no data	5		no data		24	19	E
Downtown		09:57 to 10:56	0.5	0.048	2.0	1.7	0.3	0.001	0.028	0.011	0.025	0.023	0.000	no data	4		no data		28	10	E
Lions Park		11:10 to 12:13	0.3	0.058	1.9	1.7	0.2	0.001	0.001	0.005	0.005	0.003	0.000	no data	4		no data		28	13	ESE
Brier Industrial Park		12:43 to 13:45	0.3	0.058	1.9	1.7	0.2	0.001	0.000	0.005	0.005	0.005	0.000	no data	5		no data		28	21	E
Fair grounds		14:04 to 15:15	0.2	0.062	1.9	1.6	0.2	0.000	0.000	0.003	0.003	0.005	0.000	no data	5		no data		28	20	ENE
Downtown		15:22 to 16:22	0.6	0.053	2.0	1.7	0.3	0.002	0.032	0.024	0.054	0.025	0.001	no data	5		no data		31	15	ENE
Airport		16:32 to 17:32	0.4	0.061	1.9	1.7	0.2	0.001	0.001	0.004	0.004	0.004	0.000	no data	4		no data		28	23	ENE
Brier Industrial Park		17:44 to 18:44	0.2	0.060	2.0	1.7	0.2	0.000	0.000	0.003	0.003	0.003	0.000	no data	5		no data		27	27	ENE
Lions Park		18:55 to 19:53	0.3	0.061	2.0	1.7	0.2	0.001	0.001	0.002	0.003	0.002	0.000	no data	4		no data		25	17	WSW
Fair grounds	27-May-98	07:35 to 08:33	0.5	0.024	2.1	1.8	0.2	0.000	0.002	no data			0.000	no data	5		no data		16	6	SE
Downtown		08:41 to 09:41	0.6	0.025	2.1	1.8	0.2	0.001	0.004	no data			0.000	no data	3		no data		17	7	ESE
Airport		10:13 to 11:13	0.3	0.039	2.0	1.7	0.2	0.000	0.001	0.025	0.026	no data	0.000	no data	5		no data		15	13	SSE
Brier Industrial Park		11:24 to 12:23	0.4	0.031	2.2	1.9	0.3	0.001	0.002	0.022	0.023	no data	0.000	no data	5		no data		15	12	NE
Lions Park		12:35 to 13:32	0.4	0.053	2.1	1.8	0.2	0.000	0.000	0.017	0.017	no data	0.000	no data	5		no data		17	12	E
Fair grounds		13:43 to 14:42	0.3	0.061	2.0	1.7	0.2	0.000	0.000	0.013	0.013	no data	0.000	no data	5		no data		20	17	NE
Downtown		14:52 to 15:50	0.5	0.057	2.0	1.7	0.2	0.000	0.005	0.016	0.021	no data	0.000	no data	4		no data		23	12	ENE
Lions Park		15:58 to 16:58	0.4	0.055	2.1	1.8	0.2	0.000	0.001	0.011	0.012	no data	0.000	no data	4		no data		22	10	ESE
Lions Park *		16:59 to 17:34	0.4	0.038	2.0	1.8	0.2	0.000	0.002	0.019	0.021	no data	0.000	no data	5		no data		20	15	W
Brier Industrial Park		17:50 to 18:49	0.3	0.041	2.0	1.7	0.2	0.000	0.001	0.010	0.011	no data	0.000	no data	4		no data		17	30	WSW
Downtown		19:02 to 20:01	0.2	0.039	2.0	1.7	0.2	0.000	0.000	0.008	0.008	no data	0.000	no data	5		no data		15	33	WSW
Brier Industrial Park	26-Aug-98	10:59 to 11:47	0.3	0.050	2.1	1.9	0.2	0.000	0.004	0.005	0.008	0.005	0.000	0.000	no data	35	27	5	26	15	SW
Downtown		12:00 to 12:45	0.8	0.042	2.3	1.9	0.3	0.001	0.009	0.015	0.024	0.004	0.001	0.000	no data	31	22	5	27	9	S
Lions Park		12:56 to 13:47	0.3	0.051	2.1	1.9	0.2	0.000	0.003	0.006	0.008	0.003	0.000	0.000	no data	24	17	4	29	8	SW
Fair grounds		14:00 to 14:50	0.4	0.055	2.0	1.8	0.1	0.000	0.000	0.004	0.004	0.003	0.000	0.000	no data	29	20	4	29	9	WSW
Airport		15:07 to 15:54	0.4	0.053	2.1	1.8	0.2	0.000	0.004	0.007	0.010	0.005	0.000	0.000	no data	40	28	5	29	7	SW
Brier Industrial Park		16:10 to 17:01	0.8	0.056	2.0	1.8	0.1	0.000	0.002	0.007	0.007	0.003	0.001	0.000	no data	29	20	4	29	8	WNW
Downtown		17:12 to 18:33	0.5	0.045	2.1	1.8	0.2	0.001	0.002	0.013	0.015	0.004	0.001	0.000	no data	32	23	4	28	4	WNW
Fair grounds		18:56 to 19:50	0.4	0.050	2.3	1.9	0.3	0.000	0.001	0.005	0.005	0.003	0.000	0.000	no data	68	50	8	25	4	SSE
Fair grounds	27-Aug-98	06:41 to 07:38	0.8	0.013	2.6	2.3	0.2	0.001	0.009	0.016	0.026	0.002	0.002	0.001	no data				14	4	SSE
Lions Park		07:48 to 08:49	0.6	0.022	2.2	1.9	0.1	0.001	0.001	0.006	0.008	0.003	0.001	0.000	no data				16	8	SSW
Downtown		08:58 to 09:52	1.1	0.020	2.3	2.0	0.2	0.001	0.022	0.016	0.038	0.006	0.001	0.000	no data				19	6	SSW
Airport		10:03 to 10:58	0.4	0.037	2.2	1.9	0.2	0.001	0.007	0.008	0.015	0.005	0.001	0.000	no data				22	8	SSW
Brier Industrial Park		11:09 to 12:08	0.4	0.051	2.0	1.8	0.1	0.001	0.002	0.004	0.006	0.007	0.000	0.000	no data				26	12	WSW
Fair grounds		12:37 to 13:36	0.4	0.052	2.0	1.7	0.2	0.001	0.001	0.005	0.005	0.004	0.000	0.000	no data				28	10	WSW
Lions Park		13:46 to 14:44	0.5	0.051	2.0	1.8	0.2	0.001	0.002	0.009	0.010	0.004	0.000	0.000	no data				30	5	W
Downtown		14:54 to 15:53	2.5	0.034	2.3	1.8	0.3	0.002	0.032	0.027	0.057	0.011	0.001	0.000	no data				31	6	WNW
Airport		16:03 to 17:02	0.6	0.050	2.0	1.8	0.1	0.001	0.005	0.009	0.012	0.007	0.001	0.000	no data				30	6	WNW
Brier Industrial Park		17:14 to 18:15	0.4	0.044	2.1	1.8	0.1	0.001	0.001	0.006	0.005	0.003	0.000	0.000	no data				29	13	WNW
One-hour guideline			13.0	0.082	n/a	n/a	n/a	0.170	n/a	0.210	n/a	2.0	0.010	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

no data Indicates that analyzer was not operational for indicated time period. n/a No one hour guideline.

List of Air Quality and Weather Parameters

- CO - carbon monoxide
- O_3 - ozone
- THC - total hydrocarbons
- CH_4 - methane
- RHC - reactive hydrocarbons
- SO_2 - sulphur dioxide
- NO - nitric oxide
- NO_2 - nitrogen dioxide
- NO_x - total oxides of nitrogen
- NH_3 - ammonia
- TRS - total reduced sulphur
- H_2S - hydrogen sulphide
- PAH - polycyclic aromatic hydrocarbons
- TSP - total suspended particulates
- PM_{10} - inhalable particulates
- $PM_{2.5}$ - respirable particulates
- Temp - ambient temperature
- WSP - wind speed
- WDR - wind direction

Table 7 shows one-hour average air quality parameter concentrations and weather conditions on November and January survey days at each monitoring location in Medicine Hat.

Table 7: One-hour Average Air Quality Parameter Concentrations and Weather Conditions at Each Monitoring Site in Medicine Hat (November 4 and 5, 1998 and January 27 and 28, 1999)

Monitoring Location	Date	Time (MST)	CO (ppm)	O_3 (ppm)	THC (ppm)	CH_4 (ppm)	RHC (ppm)	SO_2 (ppm)	NO (ppm)	NO_2 (ppm)	NO_x (ppm)	NH_3 (ppm)	H_2S (ppm)	TRS (ppm)	PAH (ng/m^3)	TSP ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	$PM_{2.5}$ ($\mu g/m^3$)	Temp DegC	WSP (km/h)	WDR
Fair grounds	4-Nov-98	08:07 to 09:12	0.6	0.000	2.6	2.2	0.2	0.001	0.027	0.010	0.038	0.007	0.000	no data	15	22	15	4	3	3	SE
Downtown		09:22 to 10:22	0.5	0.001	2.4	2.1	0.2	0.002	0.030	0.011	0.041	0.008	0.000	no data	18	45	29	4	5	3	SE
Lions Park		10:29 to 11:30	0.4	0.007	2.4	2.2	0.1	0.001	0.008	0.004	0.013	0.005	0.000	no data	4	23	12	2	7	3	SE
Brier Industrial Park		11:41 to 12:48	0.3	0.013	2.3	2.0	0.1	0.001	0.011	0.010	0.021	0.003	0.001	no data	6	157	92	8	7	3	S
Airport		13:05 to 14:05	0.1	0.028	2.2	1.9	0.1	0.001	0.004	0.004	0.008	0.002	0.000	no data	5	15	10	1	8	10	S
Fair grounds		14:19 to 15:17	0.1	0.026	2.2	1.9	0.1	0.001	0.001	0.005	0.006	0.000	0.000	no data	3	12	6	1	7	9	SSE
Downtown		15:28 to 16:27	0.7	0.015	2.2	1.9	0.1	0.002	0.023	0.018	0.041	0.005	0.001	no data	13	32	20	2	7	6	SSE
Lions Park		16:35 to 17:33	0.2	0.016	2.2	1.9	0.1	0.001	0.000	0.010	0.011	0.000	0.000	no data	6	29	17	2	6	7	SE
Brier Industrial Park		17:46 to 18:45	0.2	0.015	2.1	1.9	0.1	0.001	0.006	0.012	0.020	0.002	0.000	no data	6	37	22	2	4	9	SE
Airport		18:55 to 19:56	0.2	0.020	2.1	1.8	0.1	0.001	0.000	0.003	0.004	0.000	0.000	no data	2	10	6	1	2	5	SE
Fair grounds	5-Nov-98	08:29 to 09:29	no data	0.019	2.1	1.9	0.1	0.000	0.011	0.003	0.018	0.003	0.004	no data	4	12	7	1	-1	6	ESE
Lions Park		09:40 to 10:57	no data	0.029	2.2	1.9	0.2	0.000	0.010	0.001	0.013	0.001	0.003	no data	2	25	14	1	5	5	SSE
Downtown		11:06 to 12:06	no data	0.028	2.2	1.9	0.1	0.002	0.029	0.027	0.055	0.008	0.004	no data	10	36	22	2	5	4	W
Brier Industrial Park		12:16 to 13:14	no data	0.033	2.1	1.9	0.1	0.000	0.001	0.002	0.005	0.000	0.003	no data	5	213	135	12	5	6	SSE
Airport		13:26 to 14:26	no data	0.028	2.1	1.8	0.0	0.000	0.001	0.008	0.009	0.001	0.001	no data	5	62	36	3	4	9	WSW
Lions Park		14:39 to 15:40	no data	0.033	2.0	1.8	0.0	0.000	0.000	0.001	0.001	0.000	0.000	no data	2	14	9	1	4	15	ESE
Fair grounds		15:53 to 16:53	no data	0.031	2.0	1.8	0.1	0.000	0.004	0.004	0.008	0.001	0.000	no data	5	12	7	1	2	13	SE
Downtown		17:02 to 18:01	no data	0.024	2.1	1.8	0.0	0.004	0.108	0.080	0.173	0.027	0.002	no data	10	56	32	5	2	9	ESE
Brier Industrial Park		18:25 to 19:25	no data	0.030	2.0	1.8	0.1	0.000	0.008	0.004	0.012	0.004	0.001	no data	4	22	16	3	1	15	SE
Airport		19:35 to 20:33	no data	0.031	2.0	1.8	0.0	0.000	0.004	0.004	0.009	0.001	0.001	no data	2	5	3	1	1	12	ESE
Fair grounds	27-Jan-99	08:05 to 09:07	0.4	0.022	2.1	1.8	0.2	0.001	0.003	0.011	0.014	0.000	0.001	0.001	4	3	2	1	-8	8	SSW
Downtown		09:17 to 10:31	0.7	0.019	2.3	2.0	0.2	0.002	0.020	0.017	0.037	0.002	0.001	0.001	14	5	3	1	-6	5	SSE
Lions Park		10:37 to 11:43	0.7	0.021	2.3	2.0	0.2	0.002	0.014	0.013	0.027	0.000	0.001	0.001	6	19	13	2	-5	5	ENE
Brier Industrial Park		11:56 to 12:57	0.6	0.023	2.2	1.9	0.2	0.003	0.014	0.011	0.025	0.001	0.001	0.001	6	27	17	3	-4	5	SE
Airport		13:08 to 14:06	0.5	0.030	2.1	1.8	0.2	0.003	0.014	0.014	0.024	0.007	0.001	0.001	7	4	2	1	-3	18	SW
Fair grounds		14:25 to 15:26	0.6	0.030	2.0	1.8	0.1	0.001	0.004	0.007	0.011	0.001	0.001	0.001	4	4	3	1	-1	14	S
Downtown		15:38 to 16:37	1.2	0.023	2.1	1.8	0.2	0.002	0.018	0.018	0.035	0.004	0.001	0.001	27	7	5	1	0	9	S
Lions Park		16:44 to 17:44	0.7	0.027	2.1	1.8	0.1	0.001	0.001	0.010	0.011	0.001	0.001	0.001	4	7	5	1	-1	9	SSE
Brier Industrial Park		17:57 to 18:57	0.3	0.030	2.1	1.8	0.1	0.001	0.003	0.006	0.008	0.002	0.000	0.001	3	8	5	1	-3	17	S
Airport		19:08 to 20:09	0.2	0.032	2.0	1.7	0.1	0.001	0.002	0.003	0.004	0.001	0.000	0.000	2	6	4	1	-2	29	S
Fair grounds	28-Jan-99	08:10 to 09:24	0.3	0.026	2.2	1.7	0.2	0.001	0.001	0.011	0.011	0.000	0.000	0.000	6	17	11	2	0	10	W
Downtown		09:32 to 10:52	1.8	0.024	2.2	1.7	0.2	0.002	0.014	0.014	0.028	0.002	0.001	0.001	10	16	11	2	2	5	WSW
Lions Park		10:57 to 11:58	0.3	0.033	2.1	1.6	0.2	0.001	0.001	0.005	0.006	0.002	0.000	0.000	4	14	9	2	3	19	WSW
Brier Park site #5a		12:22 to 13:23	0.0	0.032	2.0	1.6	0.1	0.029	0.007	0.009	0.015	0.010	0.001	0.000	5	14	9	2	4	27	SSW
Airport		13:36 to 14:36	0.0	0.034	2.0	1.6	0.2	0.001	0.008	0.005	0.009	0.007	0.000	0.000	5	2	1	0	3	21	W
Fair grounds		14:52 to 15:54	0.1	0.030	2.0	1.6	0.2	0.001	0.001	0.007	0.009	0.002	0.000	0.000	5	7	4	1	4	11	S
Downtown		16:01 to 17:02	2.8	0.012	2.5	1.8	0.4	0.002	0.042	0.022	0.065	0.011	0.001	0.001	35	16	10	2	4	4	WSW
Lions Park		17:08 to 18:09	0.7	0.017	2.2	1.7	0.2	0.001	0.004	0.018	0.023	0.003	0.000	0.000	8	6	4	1	3	5	SW
Brier Park site #5a		18:22 to 19:23	1.1	0.006	2.2	1.7	0.2	0.003	0.009	0.027	0.037	0.001	0.001	0.001	13	4	3	1	2	2	S
Airport		19:33 to 20:35	0.3	0.014	2.2	1.7	0.2	0.001	0.008	0.020	0.029	0.002	0.000	0.000	6	10	6	1	1	4	SSW
One-hour guideline			13.0	0.082	n/a	n/a	n/a	0.170	n/a	0.210	n/a	2.0	0.010	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

no data indicates that analyzer was not operational for indicated time period n/a No one hour guideline

List of Air Quality and Weather Parameters

CO - carbon monoxide	RHC - reactive hydrocarbons	NO_x - total oxides of nitrogen	PAH - polycyclic aromatic hydrocarbons	Temp - ambient temperature
O_3 - ozone	SO_2 - sulphur dioxide	NH_3 - ammonia	TSP - total suspended particulates	WSP - wind speed
THC - total hydrocarbons	NO - nitric oxide	TRS - total reduced sulphur	PM_{10} - inhalable particulates	WDR - wind direction
CH_4 - methane	NO_2 - nitrogen dioxide	H_2S - hydrogen sulphide	$PM_{2.5}$ - respirable particulates	